IN THE DRAWINGS

The attached eight sheets of drawings include additions of FIGS. 3B, 3C, 8, 9, 10, 11, 12, and 13, changes in the page numbers of originally filed drawing sheets, and renaming FIG. 3 as FIG. 3A. Sheet 1, Sheet 2, and Sheet 3, which include FIGS. 1-4, replace the original sheets including FIGS. 1-4. Also, Sheet 5, which includes FIGS. 5, 6, and 7, replaces the original sheet including FIGS. 5, 6, and 7. No changes have been made to the four replacement sheets with the exception of minor pagination corrections in view of the newly submitted four drawing sheets and renaming FIG. 3 as FIG. 3A. The four new sheets include new FIGS. 3B, 3C, 8, 9, 10, 11. Precisely, Sheet 4 includes new FIGS. 3B and 3C, Sheet 6 includes new FIGS. 8 and 9, Sheet 7 includes new FIGS. 10 and 11, and Sheet 8 includes new FIGS. 12 and 13.

Attachment: Replacement Sheets (4); New Sheets (4)

REMARKS/ARGUMENTS

Favorable reconsideration of this Application, as presently amended and in light of the following discussion, is respectfully requested.

This Amendment is in response to the Office Action mailed on April 26, 2005. Claims 1-21 are pending in the Application, Claims 1, 2, 5, 6, 8, and 10-18 stand rejected, and Claims 3, 4, 7, and 9 have been withdrawn from consideration. Claims 1, 2, 5, 6, 8, and 10-18 are amended, Claims 3, 4, 7, and 9 are cancelled without prejudice or disclaimer, and new Claims 19-21 are added by the present Amendment.

Summarizing the outstanding Office Action, the drawings were objected to because of informalities; the specification was objected to under 37 C.F.R. §§ 1.71 and 1.75(d)(1); the abstract of the disclosure and the specification was objected to for being in improper form; Claim 18 was objected to under 37 C.F.R. § 1.75; Claims 1, 2, 5, 6, 8, and 10-18 were rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the enablement requirement; Claims 1, 2, 5, 6, 8, and 10-18 were rejected under 35 U.S.C. §112, second paragraph, for being indefinite; Claims 1, 2, 5, 6, 8, and 10-18 were rejected under 35 U.S.C. §102(b) as being anticipated by Daniel et al. (French Patent No. 2,752,024, hereinafter "Daniel"); Claims 1, 5, 6, 8, 10, 12, 13, and 16-18 were rejected under 35 U.S.C. §102(b) as being anticipated by Petrie et al. (U.S. Patent No. 3,395,857, hereinafter "Petrie"); Claims 1, 5, 10-12, 13, and 16-18 were rejected under 35 U.S.C. §102(b) as being anticipated by Buckley et al. (U.S. Patent No. 4,086,012, hereinafter "Buckley"); Claim 2 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Petrie; Claims 11 and 13-15 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Buckley in view of Mulquin (U.S. Patent No. 3,304,031); and Claims 11 and 13-15 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Petrie in view of Mulquin.

In response to the outstanding objection to FIGS. 5, 6, and 7 under MPEP § 608.02(e), Applicants have submitted herein four new drawing sheets for FIGS. 3B, 3C, 8, 9, 10, 11-13 and four replacement sheets for FIGS. 1-7, correcting the informalities noted by the Examiner and respectfully request reconsideration of the objection thereto. Applicants respectfully submit that no new matter has been added to the above-referenced application by the new and replacement drawings submitted. The new figures illustrate the invention as recited in Claims 4 and 15-18 and the replacement figures address the noted informality with regard to elements 40 and 52 in FIGS. 5-7 and contain revised page numbers in view of the new figures submitted.

In response to the objection of Applicants' abstract, Applicants have herein submitted a revised abstract to comply with that objection and respectfully request reconsideration of the same.

In response to the objection of Applicants' specification under 37 C.F.R. § 1.71 and 1.75(d)(1), Applicants have submitted herein a Substitute Specification in compliance with 37 C.F.R. §1.52(a) and (b) and respectfully request reconsideration of the same. Applicants note with appreciation the time taken by the Examiner to identify specific areas needing revisions. As required, Applicants are submitting both a Substitute Specification in clean form and another version of the Substitute Specification marked up to show all changes relative to the previous version. Applicants state that the corrections made to the Substitute Specification do not add any new matter to this Application.

Applicants respectfully traverse the objection to Claim 18 under 37 C.F.R. § 1.75 because that claim is not substantially the same as Claim 12. In Claim 12, the fusible/structural rupture members are screws 54, 72 screwed in blind holes of the intermediate casing 14 (see, as the non-limiting examples illustrated in FIGS. 3 and 4). In

Claim 18, the fusible/structural rupture members are bolts 354, 372 screwed with nuts 254, 272 through opening holes of the intermediate casing 14. As such, reconsideration of the objection to Claim 18 is respectfully requested.

Applicants respectfully traverse the outstanding rejection of Claims 1, 2, 5, 6, 8 and 10-18 under 35 U.S.C. §112, first paragraph because the burden place in the Office for such a rejection has not been carried. "The test of enablement is whether one reasonably skilled in the art could make or use the invention from the disclosures in the patent coupled with information known in the art without undue experimentation."[1]

Applicants respectfully submit that there would not be any undue experimentation for one of ordinary skill in the art to make and/or use second rupture members that break only when the load applied to the decoupler device reaches a given predetermined load. This is so because those of ordinary skill in the applicable arts know that screws and fasteners are normally dimensioned based on a given applied load. As such, no undue experimentation would be required to make/or use the second rupture members as disclosed and claimed.

The determination that "undue experimentation" would have been needed to make and use the claimed invention is not a single, simple factual determination. Rather, it is a conclusion reached by weighing several factual considerations.[2] These factual considerations are discussed more fully in MPEP § 2164.08 (scope or breadth of the claims), § 2164.05(a) (nature of the invention and state of the prior art), § 2164.05(b) (level of one of ordinary skill), § 2164.03 (level of predictability in the art and amount of direction provided by the

[1] See, for example, MPEP § 2164.01, citing *Mineral Separation v. Hyde,* 242 U.S. 261, 270 (1916). See also, *In re Wands*, 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988); and *United States v. Telectronics, Inc.*, 857 F.2d 778, 785, 8 USPQ2d 1217, 1223 (Fed. Cir. 1988).

[2] See, for example, MPEP § 2164.01(a), citing *In re Wands,* 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988).

inventor), § 2164.02 (the existence of working examples) and § 2164.06 (quantity of experimentation needed to make or use the invention based on the content of the disclosure).

However, despite the above-noted requirements for a *prima facie* case of failure to comply with the enablement requirement, the outstanding Office Action simply put forth the unsubstantiated statement of conclusion that "undue experimentation would be required of one skilled in the art to make and/or use second rupture members that break only when the load applied to the decoupler device reaches a given predetermined load." However, "the test of enablement is not whether any experimentation is necessary, but whether, if experimentation is necessary, it is undue."[3] In addition, "compliance with the enablement requirement of 35 U.S.C. § 112, first paragraph, doe not turn on whether an example is disclosed."[4]

Therefore, based on Applicants' disclosure and the knowledge of those of ordinary skill in the art, Applicants respectfully submit that one of ordinary skill in the art will be able to practice the claimed invention without undue experimentation. However, if the Office disagrees with Applicants, Applicants respectfully submit that substantive evidence be provided, fulfilling the above-noted requirements, to support a conclusion that the rejected claims do not meet the enablement requirement of 35 U.S.C. § 112.

In response to the rejection of Claims 1, 2, 5, 6, 8 and 10-18 under 35 U.S.C. §112, second paragraph, Applicants note with appreciation the time taken by the Examiner to identify specific areas needing revisions. Applicants submit that the enclosed claim amendments have overcome this rejection and respectfully request its withdrawal. It is

---

[3] See, for example, MPEP § 2164.01, citing *In re Angstadt*, 537 F.2d 498, 504, 190 USPQ 214, 219 (CCPA 1976).

[4] See, for example, MPEP § 2164.02.

believed that all pending claims are definite and no further rejection on that basis is anticipated. If, however, the Examiner disagrees, the Examiner is invited to telephone the undersigned who will be happy to work with the Examiner in a joint effort to derive mutually acceptable language.

Turning to the anticipation rejections, Applicants respectfully submit that Claim 1 is not anticipated by Daniel, Petrie, or Buckley because each and every element as set forth in that claim is not found, either expressly or inherently described, in the cited references. In an anticipation rejection, the identical invention must be shown in as complete detail as is contained in the claim.[5]

According to a feature of the invention as set forth in Claim 1, a tension decoupler device connecting two parts of a structure and fitted with rupture members is recited, comprising, among other features, a first set of first rupture members called fusible rupture members; and a second set of second rupture members called structural rupture members. The first fusible rupture members and the second structural rupture members are designed to break only when the load applied to the decoupler device reaches a given predetermined load value; and the second structural rupture members are designed to resist fatigue as long as the applied load does not reach the predetermined load value.

As disclosed in the Specification, a major drawback of conventional decoupler devices, such as the ones disclosed by Daniel, is the fact that they do not provide the ability to separately control fatigue and pure tension strengths of the fasteners used before rupture. In other words, in conventional decoupler devices, it is not possible to control fatigue strength without also the need to modify the ultimate tensile strength of the fasteners. This fatigue

[5] See MPEP 2131: "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," (Citations omitted) (emphasis added). See also MPEP 2143.03: "All words in a claim must be considered in judging the patentability of that claim against the prior art."

strength condition should preferably be provided without affecting the robustness of the decoupler device.[6]

As far as Daniel is concerned, the outstanding Office Action asserts that FIGS. 3 and 7 of that reference show fusible rupture members 17 and structural rupture members 38 distributed around a circular flange 22. Applicants respectfully disagree. In Daniel, FIG. 3 illustrated a first embodiment and FIG. 7 another different embodiment.[7] As such, contrary to the requirement that a cited reference must show the identical invention in as complete detail as is contained in the claim, the Office is proposing that the combination of two different embodiments disclosed in a reference anticipates Applicants' invention.

Daniel is summarized in Applicants' specification (see page l, line 17 – page 2, line 12) and was submitted in an Information Disclosure Statement. As explained in Applicants' specification, both embodiments of Daniel disclose first fusible rupture members without disclosing second structural rupture members. As such, this document does not teach how to control the fatigue strength of rupture members.

As to Petrie, that document discloses a bearing that comprises a bearing mounted in a housing, the housing being in turn mounted within an opening in a fixed structure. The housing comprises an end flange secured to the fixed structure by positioning means. This positioning means comprises centering means, such as frangible bolts, which rupture when subjected to a shear force exceeding a predetermined value (Petrie, col. 2, lines 28-29). The positioning means also comprises securing means, such as ordinary bolts, which continue to maintain the flange linked to the fixed structure after rupture of the centering means, and which permits the housing to move in the opening of the fixed structure while damping

---

[6] Specification, page 1, line 3 – page 3, line 24.

[7] See, for example, the brief summary of the drawings in Daniel, wherein FIGS. 3-6 illustrate first, second, and third breakable screws ("vis cassante) whereas FIG. 7 illustrates another embodiment of the invention ("un autre genre de réalizations de l'invention").

movement of the housing therein (*Id.*, col. 2, lines 35-38 and 50-58). Petrie is silent with respect to any predetermined load value and to structural rupture member designed to resist fatigue as long as applied loads are lower than a predetermined value. In addition, in the device of Petrie, the centering means is submitted to shear forces (*Id.*, col. 2, lines 49-53), whereas in the device of the invention the rupture members are submitted to tensile loads, or forces, as now recited in new Claim 19. Moreover Petrie does not disclose that the non frangible securing means can rupture after rupture of the frangible centering means, as now recited in new Claim 20.

Buckley discloses a rotational energy absorbing coupling device for absorbing part of the energy of impact of fully submerged steerable strut systems of hydrofoil ships which may encounter submerged logs, large fish, and debris. The device comprises three superimposed rings a first and a third extreme rings and an intermediate second ring. The first and third rings: contact each other and are secured to each other by means of ordinary screws. The three superimposed rings are also linked to each other by means of pins passing through holes and slots respectively disposed on the respective periphery of each ring. The first and third rings are provided with substantially round holes, the diameters of which being substantially equal to the diameter of the pins, whereas the second ring is provided with round holes, short slots and long slots. Therefore an impact load is absorbed by allowing approximately 15° of relative rotation in the rotational energy absorbing coupling through the progressive bending then shearing of a plurality of shear pins in a sequential order (Buckley, col. 3, lines 28-32).

Contrary to the subject matter recited in Claim 1, the shear pins of Buckley are not designed to rupture, but are designed to absorb energy by plastic deformation in either direction of the shear pins in the chamfered holes provided. Buckley is also silent with respect to any predetermined load value and to structural rupture member designed to resist

fatigue as long as applied loads are lower than a predetermined value. In addition, in Buckley, the pins are submitted to shear and bending forces whereas in the device of the invention the rupture member are submitted to tensile forces, or loads as recited in new Claim 19.

Applicants respectfully submit that Claim 1 is not anticipated by Daniel, Petrie, or Buckley. These references do not disclose the above-summarized features of the invention as recited in Claim 1. Claims 2, 5, 6, 8, and 10-18 should be allowed, among other reasons, as depending either directly or indirectly from Claim 1, which should be allowed as just explained. In addition, Claims 2, 5, 6, 8, and 10-18 are further considered allowable as they recite other features of the invention that are not disclosed, taught, or suggested by the applied reference when those features are considered within the context of the subject matter recited in independent Claim 1. Therefore, Applicants respectfully request that the anticipation of Claims 1, 2, 5, 6, 8, and 10-18 under 35 U.S.C. §102 be withdrawn.

Turning to the obviousness rejections, Applicants respectfully submit that Petrie, Buckley, and Mulquin, neither individually nor in any combination, support a *prima facie* case of obviousness of the invention recited in Claim 1. This is so because, even when combined, these references do not teach or suggest all the claimed features.

The deficiencies of Petrie and Buckley have already been summarized hereinabove. Mulquin, being cited for allegedly disclosing fusible rupture members having removed portions, does not remedy those deficiencies. As such, these references cannot support a prima facie case of obviousness of Claim 1.

Mulquin discloses a delayed release tension bar for a deck holdback assembly which holds an aircraft in ready position on a launching catapult until a sufficient force is applied to rupture the tension bar thereby allowing the aircraft to be launched. The tension bar has a

tension bar element with an off-set effective load axis which straightens on application of tension, whereby initial shock loading to an aircraft launching system is reduced through a controlled energy absorbing elongation incidental to the load axis straightening.

The features of Claims 11, 13-15 relate to the geometry of fusible rupture members (zone of weakness), and to the relative geometry of the fusible rupture members with respect to the structural rupture members. In the outstanding Office Action it was asserted that Buckley discloses fusible members without giving information about a reduced cross section or a removed portion and that Mulquin discloses fusible rupture members (tension bar) having removed portion and reduced cross section that can provide rupture of the fusible member under tension. It was further asserted that a person of ordinary skilled in the art would have obviously adapt the Buckley device to make rupture members with a reduced cross section or removed portions as taught in Mulquin. Applicants respectfully disagree.

Applicants respectfully submit that one of ordinary skill in the art would not be motivated to combine pins submitted to shear and bending with those related to a tension bar. Moreover, even if assuming *in arguendo* that one of ordinary skill in the art would have combined the teachings of these two references, one would have been led to make fusible rupture members having an off-set load axis, as taught by Mulquin, which is different from the device of the invention. A similar line of reasoning is sufficient to disqualify the combination of Petrie with Mulquin.

The presence or absence of a motivation to combine references is a question of fact,[8] which should be evaluated under the substantial evidence standard as required by the

---

[8] See, for example, *In re Dembiczak*, 175 F.3d 994, 1000 (Fed. Cir. 1999).

administrative Procedures Act.[9] Substantial evidence is "such relevant evidence as a reasonable mind might accept as adequate to support a conclusion."[10] Based on such a standard, the MPEP requires "[e]xplicit findings on motivation or suggestion to select the claimed invention should also be articulated in order to support a 35 U.S.C. 103 ground of rejection. . . Conclusory statements of similarity or motivation, without any articulated rational or evidentiary support, do not constitute sufficient factual findings."[11] Applicants respectfully submit that the statements made in support of a motivation to combine the cited references are merely statements of possibility[12] that disregard what each reference teaches as a whole and not of a motivation to combine satisfying the strict fact-fiding requirement just noted. In other words, the mere presence of a claimed feature in a secondary reference is insufficient to establish a motivation to incorporate that feature in the teachings of a primary reference.

Accordingly, <u>Petrie</u>, <u>Buckley</u>, and <u>Mulquin</u>, neither individually nor in any combination, render obvious the invention recited in Claim 1. Claims 2, 11, and 13-15 should be allowed, among other reasons, as depending either directly or indirectly from Claim 1, which should be allowed as just explained.

---

[9] *Dickenson v. Zurko*, 119 S. Ct. 1816, 50 USPQ 2d 1930 (1999); *In re Gartside*, 203 F.3d 1305, 53 USPQ 2d 1769 (Fed. Cir. 2000).

[10] *In re Gartside*, 203 F.3d 1305, at 1312 (Fed. Cir. 2000).

[11] MPEP § 2144.08 III.

[12] "The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990).

In addition, Claims 2, 11, and 13-15 are further considered allowable as they recite other features of the invention that are not disclosed, taught, or suggested by the applied references when those features are considered within the context of the subject matter recited in independent Claim 1. For the foregoing remarks, Applicants respectfully request withdrawal of the rejection of Claims 2, 11, and 13-15 under 35 U.S.C. § 103(a).

Finally, Applicants have submitted new Claims 19-21, which find non-limiting support on the subject matter disclosed as follows: (1) as to Claim 19, on page 8, lines 13-21 of the Disclosure; (2) as to Claim 20, on page 11, line 12 – page 12, line 4; and (3) as to Claim 21, support is self-evident from the originally filed claims and new Claims 19 and 20. Therefore, new Claims19-21 are not believed to raise a question of new matter.[13] New Claims 19 and 20 depend from Claim 1.

New independent Claim 21 recites a tension decoupler device connecting a casing of to an intermediate casing of a turbofan engine, the casing and the intermediate casing being part of a structure fitted with rupture members, the rupture of which causes decoupling of the casing and the intermediate casing. The device comprises: the casing of the turbofan engine, which includes a flange comprising first and second pluralities of holes; the intermediate casing configured to abut the flange, the intermediate casing comprising first and second pluralities of holes corresponding, respectively, to the first and second pluralities of holes in the casing; a first set of fusible rupture members inserted through both first pluralities of holes, the first set of fusible rupture members comprising a weak zone; and a first set of structural rupture members inserted through both second pluralities of holes. The first set of fusible rupture members and the first set of structural rupture members are designed to break only when a tension load applied to the decoupler device exceeds a predetermined value, the

[13] See MPEP 2163.06 stating that "information contained in any one of the specification, claims or drawings of the application as filed may be added to any other part of the application without introducing new matter."

second structural rupture members are designed to resist fatigue as long as the applied tension load does not reach the predetermined value, and the first set of fusible rupture members are designed to break first than the first set of structural rupture members.

Based at least on the above-summarized remarks and the dependency of Claims 19 and 20, Applicants respectfully submit that new Claims 19-21 should be allowed over all of the references of record.

Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application, and the present application is believed to be in condition for formal Allowance. A Notice of Allowance for Claims 1-21 is earnestly solicited.

Should the Examiner deem that any further action is necessary to place this application in even better form for allowance, the Examiner is encouraged to contact Applicants' undersigned representatives at the below listed telephone number.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

Philippe J.C. Signore, Ph.D.
Attorney of Record
Registration No. 43,922

Mardson Q. McQuay, Ph.D.
Registration No. 52,020

Customer Number
22850

Tel: (703) 413-3000
Fax: (703) 413 -2220
(OSMMN 06/04)

PJS/MQM:fm
I:\ATTY\MQM\24'S\242818US\AMD 10-26-05.DOC

TENSION DECOUPLER DEVICE

DESCRIPTION

Technical field

This invention relates to a tension decoupler device provided with screws intended for use particularly on a fan shaft bearing support in a turbojet.

State of prior art

A tension decoupler device provided with screws has already been disclosed in document FR 2 752 024.

This document describes a bearing support that holds a roller bearing in place. The bearing support is fixed to an intermediate casing by a flange associated with a set of assembly screws all parallel to the engine centre line.

When the bearing support is subjected to a large load due to an out of balance mass caused by the rupture of a blade, said load is no longer transmitted to the intermediate casing and then to the rest of the structure because it is prevented from doing so by the presence of a decoupler device placed between said bearing support and said intermediate casing.

A first embodiment of FR 2 752 024 specifies that decoupling takes place by rupture of assembly screws between the bearing support and the intermediate casing. This is achieved by providing a turned zone or a locally zone of weakness on said screws, that are called "fusible screws".

The decoupler device is composed of a combination of the flange and assembly screws.

A second embodiment of FR 2 752 024 specifies that decoupling should take place by rupture of a zone behind the bearing support close to the connection of said bearing support with the intermediate casing. This is achieved by providing a weakened zone in the rupture zone of the bearing support. In this case, assembly screws between the bearing support and the intermediate casing are ordinary screws and are not designed to break.

The out of balance mass applies a cyclic radial force to the shaft, which is converted into a cyclic axial force that acts in tension on the zone of weakness of the decoupler device, through the shape and the size of the bearing support. In the two embodiments of FR 2 752 024, the zone of weakness is adapted so that it will break when the applied load reaches or exceeds a predetermined load value, particularly through control of its dimensions.

In practice, it is not only desirable that the decoupler device should break under the effect of a large out of balance mass, but it is also often desirable that it should be capable of resisting a moderate out of balance mass for a given time.

In practice, a large out of balance mass may be caused by the loss of a blade, and in this case it is desirable that decoupling should take place; a moderate out of balance mass could be caused by ingestion of a bird by the turbojet, and in this case it is desirable that the decoupler device should resist this moderate out of balance mass to prevent decoupling from occurring too often.

When the decoupler device is subjected to a load greater than the predetermined load, it fails by rupture of the screws. But when it is subjected to a load less than said predetermined load, it does not fail but it may possibly be damaged if the load is large enough to cause local deterioration or deformations to its constituent elements (fusible screws and/or flange, and its life is reduced).

This fatigue strength condition should preferably be provided without affecting the robustness of the decoupler device.

With the decoupler device described in FR 2 752 024, the manufacturer does not have separate control over the fatigue strength of screws and their strength to pure tension before rupture. In other words, it is not possible to control the fatigue strength of this decoupler device, without also modifying its ultimate tensile strength. This is a major disadvantage in the decoupler device according to the prior art.

Summary of the invention

The present invention is an improvement to the first embodiment of the decoupler device described in document FR 2 752 024, which relates to a decoupler device with tensile stressed screws.

The aim of this invention is to provide a tension decoupler device that does not have the disadvantages of devices according to prior art mentioned above.

One purpose of the invention is to be able to increase the fatigue strength of a given decoupler device designed to fail when it is subjected to a given load.

According to the invention, the tension decoupler device connecting two parts of a structure and. fitted with rupture members, the rupture of which cause decoupling of said parts when they break, is characterized in that it comprises:

- a first set of first rupture members called fusible rupture members, arranged to be parallel to each other,

- a second set of second rupture members called structural rupture members, arranged to be parallel to each other and parallel to the first rupture members,

and in that said first; fusible rupture members and said second structural rupture members are designed to break only when the load applied to the decoupler device reaches or exceeds a given predetermined load value, and said second structural rupture members are designed to ~~have sufficient fatigue strength as long as said applied load does not reach said~~

~~predetermined load value~~resist fatigue as long as said applied load does not reach said predetermined load value.

According to a preferred embodiment of the invention, the rupture members are fusible screws and structural screws.

According to one aspect of the invention, the decoupler device is characterized in that the first fusible screws comprise a zone of weakness between their head and their thread, that acts as a trigger or initiation site for the tensile rupture.

According to another aspect of the invention, the shape of the second structural screws is thicker than said first fusible screws, and their stiffness is greater.

According to another embodiment of the invention, the rupture members are fusible rivets and structural rivets.

According to still another embodiment of the invention, the rupture members are fusible bolts and structural bolts.

The decoupler device according to the invention has the advantage that it becomes possible for the manufacturer to design structures using lighter weight and/or less expensive materials, for example such as aluminium.

Brief description of the drawings

Other aspects and advantages of the invention will become more apparent from the following description of a preferred, but not limitative embodiment, taken in conjunction with the accompanying in which:

- figure 1 is a longitudinal sectional view of a portion of a turbojet illustrating a general environment of the invention;

- figure 2 is another longitudinal section showing an enlarged view of part of the previous figure, showing the embodiment of the invention in more detail;

- figure 3A illustrates a longitudinal section of a fusible screw according to the invention;

- figure 3B illustrate a longitudinal section of an alternative fusible screw according to the invention;

- figure 3C illustrate a longitudinal section of an alternative fusible screw according to the invention;

- figure 4 illustrates a longitudinal section showing the flange and a structural screw according to the invention;

- figures 5, 6, 7, 8 and ~~7~~9 illustrate variant distributions of fusible screws and structural screws around the periphery of the flange~~.~~;

- figures 10 and 11 illustrate an alternative embodiment of the invention, according to which the rupture members are fusible rivets and structural rivets; and

- figures 12 and 13 illustrate yet an alternative embodiment of the invention, according to which the rupture members are fusible bolts and structural bolts.

Detailed presentation of an embodiment of the invention

The invention will, now be described by illustrating a preferred embodiment in which the rupture members are fusible screws and structural screws.

Figures 1 and 2 illustrate an example environment in which the decoupler device according to the invention can be used.

With reference firstly to figure 1, a fan 6 of a turbojet with a centre line 100, driven and supported by a rotating shaft 2, is located in front of a low pressure shaft line 1. The fan 6 is fitted with blades 7 that extend in front of the inlet of an internal stream 8 or a main gas flow stream, in front of the inlet of an external stream 9 surrounding the internal stream 8

along which gas dilution air passes. A low pressure compressor 10 and a high pressure compressor 11 are located in the internal stream 8.

The rotating shaft 2 supports the fan 6 at its front end 5 and extends backwards starting from the fan 6, the shaft 2 being supported by a first bearing 3 behind the fan 6 and by a second bearing 4 behind the first bearing 3.

Now with reference to Figure 2, the first bearing 3 is supported by a casing 15 surrounding the shaft 2 and extending backwards from the first bearing 3 as far as an intermediate casing 14, to which the casing 15 is connected through a link 17. The rear bearing 4 is supported by a support 16, itself connected to the casing 15 through a link 18.

If a blade 7 of the fan 6 breaks, a large out of balance mass is created on shaft 2, which generates cyclic loads and vibrations that are transmitted to the fixed parts of the machine through the first support bearing 3 of the shaft 2, creating serious risks of deterioration.

The connection 18 between the casing 15 and the support 16 of the rear bearing 4 is made by an assembly of standard screws.

The connection 17 between the casing 15 and the intermediate casing 14 is made using a decoupler device according to the present invention.

This decoupler device will be described with reference to Figures 3 and 4. It comprises a flange 52 fixed to the back end of the casing 15.

The flange 52 is approximately circular in shape and is centred on the centre line 100, and is arranged approximately perpendicular to said centre line 100.

The flange 52 is provided with first through orifices 42 in which the first assembly screws 54 are inserted, and second through orifices in which second assembly screws 72 are inserted. The dimensions of the through orifices 42, 44 are actually appropriate for the dimensions of the screws 54 and 72 that fit into them.

The flange 52 is sized such that the force transmitted to the screws is a pure tension force.

The screws 54, 72 form the decoupling means of the decoupler device. They are of two different types, and their shapes and dimensions are different so that they can fulfil different functions.

A first screw assembly is composed of screws called fusible screws 54 that are sized to break in response to a given tension load.

They are illustrated in Figure ~~3~~3A and they are substantially similar to the fusible screws described in FR 2 752 024. They are arranged to be parallel to each other.

The fusible screws 54 have a screw head 56, a thread 58, a smooth part 62 between the head 56 and the thread 58, and a zone of weakness or weakened zone, also called a fusible zone 64, sized as a function of the value of the predetermined load at which said fusible screws 54 are required to break. In use, the thread 58 of the fusible screws 54 is fitted in a tapping in the intermediate casing 14 and their head 56 rests on a free surface 60 of the flange 52. In use, the fusible zone 64 is always located inside the through orifice 12 of the flange 52 in which the fusible screw 54 is fitted. For example, the fusible zone 64 may be obtained by a restriction in the diameter, as illustrated on Figure ~~3~~3A. It can also be obtained by drilling, as illustrated in Figure 3B, and/or weakening the ultimate mechanical strength by applying a particular treatment to it, for example such as a local heat treatment by local dipping, as illustrated in Figure 3C.

A second screw assembly is composed of screws called structural screws 72. They are arranged to be parallel to each other and parallel to the fusible screws 54. These screws are also sized so that they break in response to a given tension load, but also to resist as long as said load does not exceed a given predetermined value. Therefore, unlike the fusible

screws 54, the structural screws 72 are capable of resisting fatigue for a given applied load value.

The structural screws 72 are illustrated in Figure 4. They have a screw head 76 and a thread 78. Unlike the fusible screws 54, they do not have a zone of weakness, and therefore their thread 78 preferably extends substantially over the entire length of the screw body. In use, the threads 78 of the structural screws 72 are fitted in a tapping in the intermediate casing 14 and their heads 76 are supported on a free surface 80 of the flange 52.

The structural screws 72 are thicker than the fusible screws 54, and in particular their screw body diameters are greater than, the diameters of the fusible screws 54. Their stiffnesses are also higher than the stiffnesses of the fusible screws 54, for example they may be twice as high.

The forces originating from shaft 2 are transmitted mainly through the structural screw 72 to the intermediate casing 14. The forces transmitted are mainly in the axial direction, shear forces being resisted mainly by the alignment of structural screws 72.

Now will be described details of the behaviour of the decoupler device according to the invention in various possible situations, and in comparison with prior art.

Starting by considering a first situation in which the structure is subjected to the effect of a moderate out of balance mass, the applied load being less than the predetermined load that will cause rupture of the decoupler device. With a decoupler device according to prior art, in other words in the absence of the structural screws 72, the fusible screws 54 will be elongated by elastic deformation and then possibly plastic deformation under the effect of the axial tension stress, without this deformation causing rupture of the fusible screws 54. If the plastic deformation of the fusible screws 54 is large, the flange 52 may deform in turn and/or separate from the intermediate casing 14, which reduces the mechanical strength of the decoupler device. With a decoupler device according to the invention, in other words

comprising a combination of fusible screws 54 and structural, screws 72, the structural, screws 72 will only be slightly elongated or will not be elongated at all. This prevents, or at least limits, deformation and/or separation of the flange 52.

Consequently, the presence of the structural screws 72 has the effect of improving the fatigue strength of the decoupler device and increasing its life provided that the applied load remains less than the predetermined load that causes rupture of the fusible screws 54.

Considering now a second situation in which the structure is subjected to the effect of a large out of balance mass, the applied load being greater than or equal to the predetermined load that causes rupture of the decoupler. With a decoupler device according to prior art, in other words in the absence of structural screws 72, there will be an elongation of the fusible screws 54 by plastic deformation under the effect of the axial tension force, until rupture of said fusible screws 54, in accordance with the description given in FR 2 752 024. With a decoupler device according to the invention, in other words including both fusible screws 54 and structural screws 72, there will be an elongation of the fusible screws 54 and the structural screws 72 by plastic deformation under the effect of the axial tension force, if the applied load is greater than or equal to the value of the predetermined load. The result is separation of the flange 52, which consequently causes a sudden load in the fusible screws 54. These screws then fail one after the other or simultaneously. The result is that the structural screws 72 are overload and fail in turn. Decoupling takes place.

Consequently, the presence of the structural screws 72 does not hinder the role of the decoupler device when it is subjected to a load greater than the predetermined load that causes rupture.

In decoupler devices according to prior art, the elastic rupture limit of the decoupler device in provided by the elastic rupture limit of the fusible screws. In decoupler devices according to the invention, the elastic rupture limit of the decoupler device is given by the

elastic rupture limit of the structural screws. Therefore, the presence of the structural screws increases the elastic rupture limit of the decoupler. For example, the fusible screws 54 and the structural screws 72 can be sized such that the elastic rupture limit of the device according to the invention is 40% greater than the elastic rupture limit of the decoupler device according to prior art.

It has been seen that the fusible screws 54 are sized so as to predetermine the value of the axial tension force, and therefore the load applied on the input side that causes decoupling. Moreover, the fusible screws 54 and the structural screws 72 are pretightened during their installation by an appropriate value, such that the structural screws 72 do not fail before the fusible screws 54.

One important aspect of decoupler devices according to the invention is in the roles of the fusible screws and structural screws. In devices according to prior art, rupture of the decoupler device is caused by rupture of the fusible screws, and the fatigue limit of the decoupler device is given by separation of the flange held by the same fusible screws. In decoupler devices according to the invention, rupture of the decoupler device is still caused by rupture of the fusible screws 54, while the fatigue limit of the decoupler device depends on separation of the flange held in place by the structural screws 72.

Consequently, with a decoupler device according to the invention, comprising both fusible screws 54 and structural screws 72, it is advantageously possible to control rupture of the decoupler device and the fatigue limit of the decoupler device separately.

Now will be described examples of the arrangement and distribution of fusible screws 54 and structural screws 72 in relation to Figures 5 to 7.

Preferably, the centre line of the through orifices 42 provided for the first fusible screws 54 and the through orifices 44 provided for the second structural screws 72 are located

around an average circular line 40, 140, 240, 340, 440 of the flange 52, 152, 252, 352, 452, with an alternating distribution, as illustrated on Figures 5, 6, 7, 8 and 9, respectively.

According to a first variant embodiment illustrated on Figure 5, said alternating distribution is such that each orifice 42 for fusible screws 54 is located between two orifices 44 for structural screws 72, and similarly each through orifice 44 for structural screws 72 is. located between two through orifices 42 for fusible screws 54.

According to a second variant embodiment illustrated in Figure 6, said alternating distribution is such that the through orifices 42 for fusible screws 54 and the through orifices 44 for structural screws 72 are grouped, in pairs, each pair of through orifices 42 for fusible

screws 54 being located between two pairs of through orifices 44 for structural screws 72, and similarly each pair of through orifices 44 for structural screws 72 being located between two pairs of through orifices 42 for fusible screws 54.

Actually, other variants of the alternation of through orifices 42 for fusible screws 54 and through orifices 44 for structural screws 72 could be envisaged.

According to one variant (not shown), the distribution of screws may be made with zones of several fusible screws 54 alternating with zones of several structural screws 72.

According to a third variant embodiment illustrated on Figure 7, said alternating distribution is such that the through orifices 42 for fusible screws 54 are distributed on a first average line 40 of the flange 52, and the through orifices for structural screw:, 72 are distributed on, a second average line 41 of the flange 52, the second average line 41 being concentric with the first average line 40, working towards or away from the centre line 100.

Other distribution methods could also be considered combining variant alternations and/or increased distance from the centre line 100.

Furthermore, although three variant distributions have just been described in which the number of fusible screws 54 and the number of structural screws 72 are identical, it would also be possible to envisage other variant distributions in which the number of fusible

screws 54 is larger than the number of structural screws 72, as illustrated in Figure 8, or in which the number of fusible screws 54 is less than the number of structural screws 72, as illustrated in Figure 9.

The choice of the method of distribution of the two types of screws and/or the choice of the number of screws is always made as a function of the required effects.

The invention that has just been described is not limited to a decoupler device in which parts are assembled by fusible screws and structural screws, but it may also be extended to include other embodiments in which sets of fusible rivets 154 (see Figure 10) and structural rivets 172 (see Figure 11), or sets of fusible bolts 254 (see Figure 12) and structural bolts 272 (see Figure 13), are used as the decoupling means instead of screws.